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VANDERBILT Reporter

Specialties Department

No. 916

VANZAN™

Xanthan Gum

Introduction

Xanthan gum is a high molecular weight exocellular polysaccharide derived from the bacterium *Xanthomonas campestris* using a natural, aerobic fermentation process. The process is conducted in a sterile environment where the pH, oxygen content and temperature are rigorously controlled. After fermentation is complete, the broth is sterilized and the gum is recovered by precipitation with isopropyl alcohol, then dried, milled and packaged under sterile conditions.

R.T. Vanderbilt Company's xanthan gum bears the trade name VANZAN. It is widely used as a rheology control agent for aqueous systems. It increases viscosity, helps to stabilize emulsions, and prevents the settling of solids in a wide variety of consumer and industrial applications.

VANZAN grades are available for both pharmaceutical and technical applications. Pharmaceutical grades are also recommended for personal care applications; technical grades are recommended for household/institutional products and industrial applications.

Technical Grades

These grades are recommended for household/institutional products, as well as for a variety of industrial applications. Key properties of these technical grades are summarized below:

VANZAN Technical Grades

Trade Name	Viscosity, mPa•s	pH[3]	Moisture, %	Particle Size
VANZAN	1400 - 1600[1]	5.5 - 8.5	15 max.	95% min. −80 mesh (180 μm)
VANZAN D	800 - 1400[2]	4.5 - 7.0	15 max.	95% min. −45 mesh (355 μm)

[1] 1.00% VANZAN in 1% KCl solution, measured at 25°C using Brookfield Model LV viscometer at 60 rpm with Spindle #3.
[2] 1.00% VANZAN D in deionized water, measured at 25°C using Brookfield Model LV viscometer at 60 rpm with Spindle #3.
[3] 1.00% VANZAN in deionized water at 25°C.

VANZAN is the **general purpose** grade suitable for most household, institutional and industrial applications.
VANZAN D provides **easy dispersion** with rapid viscosity development, without the formation of lumps or "fish eyes".

Pharmaceutical and Personal Care Grades

Five grades of VANZAN Xanthan Gum are available to the pharmaceutical and personal products industries. Key physical properties and features of these grades are summarized below.

All pharmaceutical grades of VANZAN (those designated with the suffix "NF") conform to the requirements of the Xanthan Gum monograph in USP 24/NF 19.

VANZAN Pharmaceutical/Personal Care Grades

Trade Name	Viscosity, mPa•s[1]	pH[2]	Moisture, %	Particle Size
VANZAN NF	1400 - 1600	6.0 - 8.0	15 max.	95% min. −80 mesh (180 μm)
VANZAN NF-F	1400 - 1600	6.0 - 8.0	15 max.	92% min. −200 mesh (75 μm)
VANZAN NF-C	1300 - 1700	6.0 - 8.0	12 max.	95% min. −80 mesh (180 μm)
VANZAN NF-ED	1300 - 1700	6.0 - 8.0	15 max.	100% −16 mesh (1.18mm)
VANZAN NF-ST	1300 - 1700	6.0 - 7.0	12 max.	92% min. −200 mesh (75 μm)

[1] 1.00% VANZAN in 1% KCl solution, measured at 25°C using Brookfield Model LV viscometer at 60 rpm with Spindle #3.
[2] 1.00% VANZAN in deionized water at 25°C.

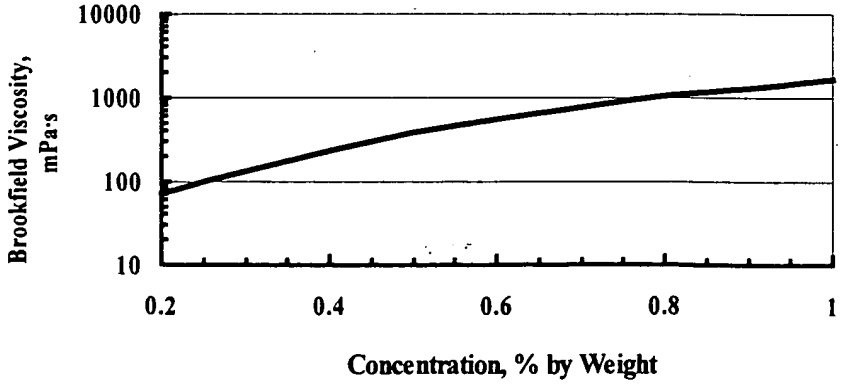
VANZAN NF is the **general purpose** grade suitable for most pharmaceutical and personal care applications.
VANZAN NF-F is a **finely ground powder** designed for applications such as tablets and dry mix powder formulas.
VANZAN NF-C produces **clear** xanthan gum solutions for applications where product clarity is essential, such as syrups and gels.
VANZAN NF-ED provides **easy dispersion** with rapid viscosity development, without the formation of lumps or "fish eyes".
VANZAN NF-ST tolerates a significantly greater amount of **dissolved salts** in the formulation. It is a finely ground powder.

RHEOLOGICAL PROPERTIES

Thickening Efficiency

VANZAN Xanthan Gum is a highly efficient thickener and rheology modifier for aqueous-based systems. Concentrations as low as 0.1% by weight can effect significant increases in viscosity. Concentrations greater than 1.0% by weight can produce very high viscosity systems with gel-like consistency. The relationship between the concentration of VANZAN NF and the viscosity of the aqueous solution is shown below.

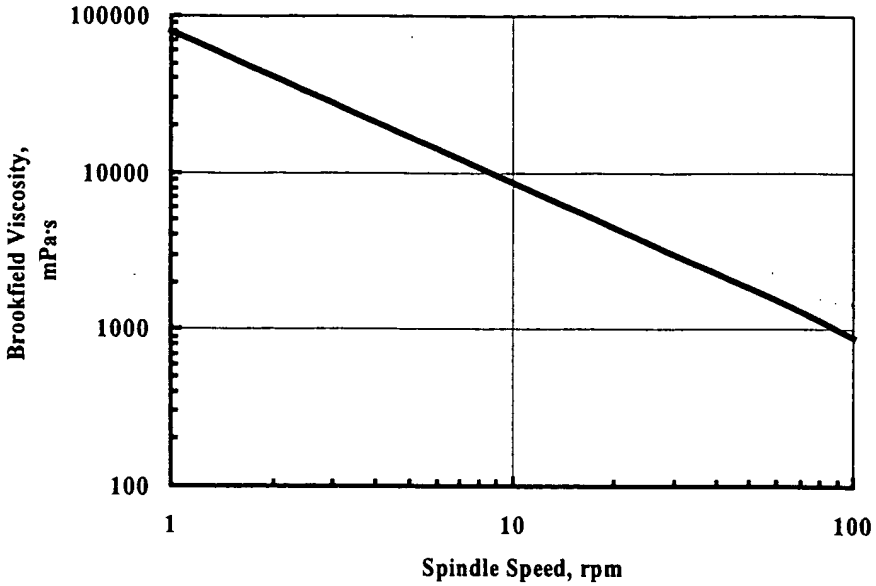
Viscosity vs. Concentration of VANZAN NF



Pseudoplasticity

Aqueous solutions and formulated products containing VANZAN exhibit a high degree of pseudoplasticity. The viscosity of the solution decreases significantly as the rate of shear increases, as depicted below. The viscosity is very high when the composition is at rest or subjected to low levels of shear, but at high shear, which is frequently encountered when the formulated product is used, the viscosity is significantly lower.

Pseudoplasticity of a 1.0% VANZAN Solution



Yield Value

VANZAN imparts a yield value (also known as yield stress) to compositions. The definition of yield value is the minimum force per unit area required to initiate flow. From a practical standpoint, this means that a positive force must be applied to the fluid to get it to flow. Because of the yield value imparted by VANZAN, the stability of oil/water emulsions is enhanced, and water-insoluble particulates such as pigments and abrasives are kept permanently suspended. A number of other hydrocolloid rheology modifiers develop yield value, but VANZAN is one of the most effective.

Effect of Temperature

The rheology of aqueous VANZAN solutions is remarkably stable over a broad temperature range, as shown in the following table. The viscosity and yield value of compositions containing the gum will not change significantly between ambient temperature and 60°C. VANZAN provides the same thickening, stabilizing and suspending properties during long-term storage at elevated temperature as it does at ambient conditions. In addition, it imparts excellent freeze/thaw stability to most compositions.

Effect of Temperature on Solution Viscosity

VANZAN, wt.%	Measurement Temperature, °C	Viscosity, mPa•s
1.0	20	1550
1.0	40	1550
1.0	60	1500
0.5	20	550
0.5	40	500
0.5	60	450

Effect of pH

VANZAN is recommended for use in both acidic and alkaline systems. As shown in the table below, the viscosity remains nearly constant between pH 2 and pH 12. Below pH 2 and above pH 12, the viscosity tends to decrease slightly. This makes VANZAN an excellent choice for compositions containing relatively high concentrations of acids or bases.

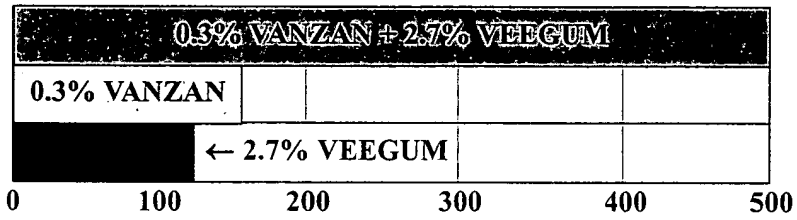
Viscosity vs. pH in VANZAN Solutions

pH	2	4	6	8	10	12
Viscosity @ 1.0%, mPa•s	1550	1550	1550	1550	1550	1550
Viscosity @ 0.5%, mPa•s	500	550	550	550	550	500

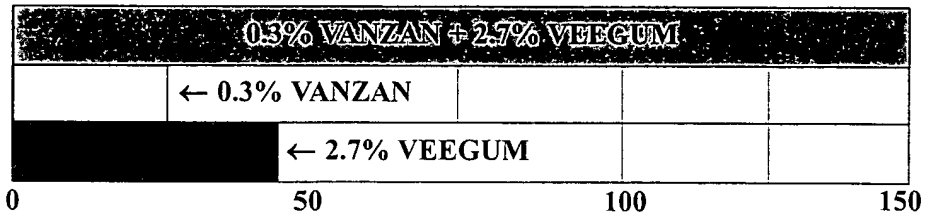
Rheology Synergism

Mixtures of xanthan gum with water-swellable clays or certain galactomannans produce synergistic rheological effects. The mixtures produce greater viscosity and yield value (and therefore greater thickening, stabilizing and suspending properties) than those developed by the individual components of the mixture. A water-swellable clay that is particularly effective in combination with VANZAN is VEEGUM Magnesium Aluminum Silicate, which is also available from R.T. Vanderbilt Company. A weight-to-weight ratio of VANZAN to VEEGUM between 1:9 and 1:2 generally produces the most desirable results. The figures below demonstrate the synergism between VANZAN and VEEGUM.

VANZAN - VEEGUM Synergism



Viscosity, mPa•s



Yield Value, Dynes/cm² (Pa/10)

Mixtures of VANZAN and VEEGUM Magnesium Aluminum Silicate produce 1.4 to 1.8 times the viscosity as compared to the sum of the viscosity developed by individual components of the mixture. The combination also produces 1.7 to 2.1 times the yield value as compared to that expected from the sum of the individual components.

Strong synergistic effects are exhibited by mixtures of xanthan gum with galactomannans like guar gum and locust bean gum. Weight to weight ratios of VANZAN to guar gum between 1:1 and 1:9 are recommended. The synergism with locust bean gum is even stronger than that with guar gum. A weight to weight ratio of 1:1 is recommended for most applications. At concentrations greater than 0.2%, mixtures of xanthan gum and locust bean gum will form thermally reversible gels when heated above 55°C and subsequently cooled.

COMPATIBILITY GUIDELINES

Solvents

Because VANZAN is an anionic polysaccharide, it is compatible with other anionic and nonionic ingredients. However, VANZAN is not generally compatible with cationic species, which can cause interactions that lead to the precipitation of both components. It is also incompatible with strong oxidizing agents such as NaOCl and H_2O_2, which can cause rapid to severe degradation of the polymer.

Xanthan gum is compatible with aqueous solutions of common water-miscible solvents. 1% VANZAN solutions, for example, can contain up to 40% to 50% glycerol, glycols, glycol ethers, and alcohols without precipitation of the gum.

Acids and Bases

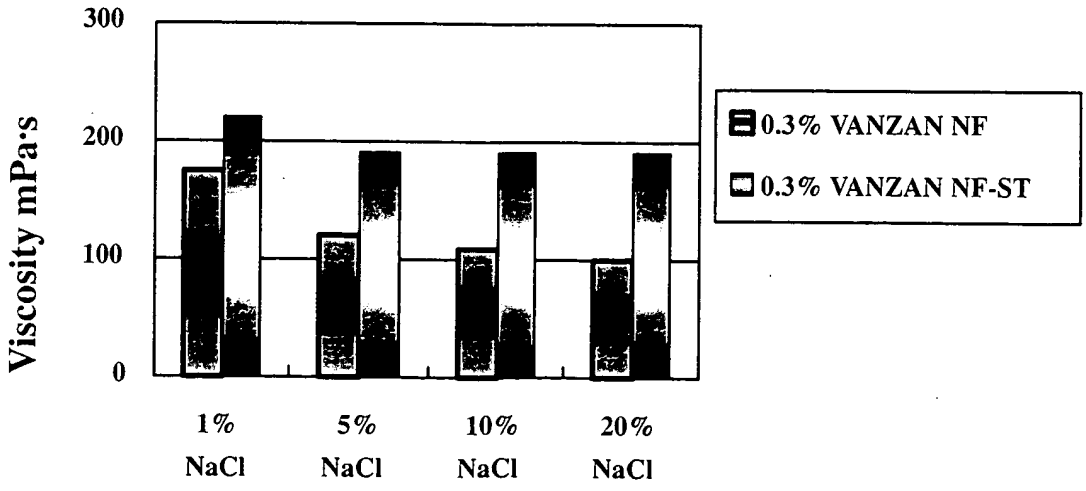
VANZAN exhibits excellent compatibility in many strong mineral acid solutions, including those containing 5% hydrochloric, 10% sulfuric or 40% phosphoric acid, as well as in organic acid solutions such as those containing 20% acetic, citric or tartaric acid. Little or no change in viscosity occurs during storage of these acid solutions for three months at ambient temperature.

Xanthan gum also has excellent stability in alkaline systems. VANZAN provides excellent long-term viscosity stability in alkaline systems including those containing 5% sodium carbonate, 10% sodium hydroxide, 5% sodium metasilicate or 5% sodium phosphate.

Salts

Xanthan gum is compatible with aqueous solutions containing 10% to 15% and in some cases up to 30% of common inorganic salts. These high electrolyte content solutions maintain stable viscosity over extended storage periods. Divalent salts, such as those of calcium, magnesium and barium can cause the gelation and/or precipitation of xanthan gum at alkaline pH (pH >10). Trivalent salts, such as those of alumium, iron and chromium can cause gelation at acid and neutral pH levels as well. One grade of VANZAN is specially designed for use in systems containing high salt concentrations: VANZAN NF-ST. It hydrates and dissolves more rapidly, and its viscosity is relatively unaffected by high salt levels as compared to the general purpose grade, VANZAN NF, as shown below:

Superior Salt Tolerance of VANZAN NF-ST



APPLICATIONS

Grades of VANZAN that include the suffix "NF" meet the requirements of the National Formulary's monograph on Xanthan Gum, and are therefore acceptable for use in pharmaceutical products. They are also recommended for personal care applications. Grades of VANZAN without the "NF" designation are technical grades recommended for household, institutional and other industrial applications.

The following charts summarize the recommended applications for VANZAN, the functions performed in the application, and the grade(s) recommended for the specific application.

Pharmaceutical Applications

Application	Thickener	Suspending Agent	Emulsion Stabilizer	Gelling Agent	Foam Stabilizer	Stabilizer	Recommended Grade(s)
Dental Care							
Dental Impression Materials				✓		✓	VANZAN NF-F
Dental Treatment Gels	✓			✓			VANZAN NF & NF-C
Therapeutic Products							
Acne Treatment Lotions	✓	✓	✓				VANZAN NF & NF-ED
Antacid Suspensions		✓					VANZAN NF & NF-ED
Antidiarrheal Suspensions		✓					VANZAN NF & NF-ED
External Analgesics	✓		✓				VANZAN NF & NF-ED
Oral Syrups & Elixirs	✓						VANZAN NF-C
Other Pharmaceuticals							
Anti-Dandruff Shampoos	✓	✓			✓		VANZAN NF & NF-ED
Ophthalmic Liquids	✓						VANZAN NF-C
Tablet Coatings	✓	✓				✓	VANZAN NF-F

Personal Care Applications

Dental Care							
Dentifrice Pastes, Gels	✓			✓		✓	VANZAN NF, NF-F & NF-C
Hair Care							
Shampoos	✓				✓		VANZAN NF & NF-C
Styling Creams & Gels	✓		✓	✓			VANZAN NF & NF-C
Perms & Hair Straighteners	✓			✓			VANZAN NF
Liquid Soaps & Bath Gels	✓		✓	✓	✓		VANZAN NF & NF-C
Skin Care							
Liquid Makeup, Mascara & Eye Shadow	✓	✓	✓				VANZAN NF
Depilatories	✓		✓				VANZAN NF-ST
Roll-on Deodorants & Antiperspirants	✓	✓					VANZAN NF
Skin Creams & Lotions	✓		✓				VANZAN NF
Sunscreens	✓	✓	✓				VANZAN NF

Household, Institutional & Industrial Applications

Application	Thickener	Suspending Agent	Emulsion Stabilizer	Gelling Agent	Foam Stabilizer	Stabilizer	Recommended Grade(s)
Household/Institutional Products							
Acid Toilet Bowl Cleaners	✓			✓	✓		VANZAN
Auto Cleaner & Polish	✓	✓	✓				VANZAN
Automatic Dishwasher Detergents(w/o Bleach)	✓				✓		VANZAN & VANZAN D
Basin, Tub and Tile Cleaners	✓	✓			✓	✓	VANZAN
Metal Cleaners & Polish	✓	✓			✓		VANZAN
Oven & Grill Cleaners	✓				✓		VANZAN & VANZAN D
Waterless Hand Cleaners	✓	✓	✓			✓	VANZAN
Industrial Products							
Agricultural Flowables	✓	✓	✓				VANZAN
Adhesives	✓						VANZAN
Carpet Printing Pastes	✓	✓					VANZAN
Ceramic Glazes	✓	✓					VANZAN
Printing Inks	✓	✓					VANZAN
Water-Based Paints & Coatings	✓	✓	✓				VANZAN

PREPARATION OF SOLUTIONS

VANZAN products are soluble in both cold and warm water. Water temperature has little effect on the dissolution rate of VANZAN.

Differences in dissolution characteristics between different grades exist primarily because of differences in particle size. Specifically, VANZAN NF-F and VANZAN NF-ST are very fine powders; VANZAN, VANZAN NF and VANZAN NF-C are granular; and VANZAN NF-ED and VANZAN D are coarse granules. Each of these three categories exhibits slightly different dissolution characteristics and, consequently, the recommended method to prepare the solution also differs.

VANZAN, VANZAN NF & VANZAN NF-C

When dissolving VANZAN, VANZAN NF or VANZAN NF-C, the mixer should develop a deep vortex in the water in the mix tank. The gum should be slowly sifted into the upper wall of the vortex.

The gum should never be dumped into the water, and large amounts of VANZAN should not be allowed to float on the surface of the water during mixing. This can cause the formation of lumps or "fish eyes" that take much longer to dissolve. Although xanthan gum is not very sensitive to shear, propeller mixers are preferable to homogenizers for the preparation of solutions. Mixing should continue until the solution is smooth and uniform, which usually takes about 30 minutes, or longer for larger batches.

VANZAN NF-F & VANZAN NF-ST

The fine powder grades, VANZAN NF-F and VANZAN NF-ST, require immediate and thorough dispersion of the gum particles as soon as they contact water; otherwise lumps will form that are difficult to dissolve. High efficiency mixers that keep the gum particles well dispersed until they dissolve are essential. Pre-dispersion of the gum in a water-miscible liquid such as an alcohol or glycol helps to prevent the formation of lumps. A ratio of gum to water-miscible liquid between 1:2 and 1:10 is recommended. Dry-blending the gum with another ingredient of similar particle size can also be helpful in avoiding the formation of lumps.

VANZAN NF-ED & VANZAN D

VANZAN NF-ED and VANZAN D are specially designed, easy-to-disperse coarse granular grades. In the case of VANZAN NF-ED, the larger particle size and smaller effective surface area enables the gum to disperse well and hydrate more slowly in a well-mixed system. As a result there will be less of a tendency to form lumps or "fish eyes". The development of viscosity will be slower with VANZAN NF-ED, but the overall mixing time required should only be slightly longer than that of other grades.

VANZAN D is a surface-treated grade. The surface treatment allows good dispersion of the particles, even with relatively slow mixing. It also prevents the hydration and dissolution of the gum until the surface treatment is removed by raising the pH of the system to 9 or greater, following which rapid viscosity development will occur. This has the advantage of allowing the formulator to decide when to thicken the composition. It is particularly useful for systems where the final pH is to be alkaline.

REGULATORY STATUS

Grades of VANZAN including the suffix "NF" are pharmaceutical grades and, as such, conform to the requirements of the following regulatory standards:

United States Pharmacopoeia/National Formulary, USP 24/NF 19, (2000), p2537

British Pharmacopoeia, (1998), p1373

European Pharmacopoeia, 3rd Edition, 2nd Supplement (1998), p1277

Japanese Pharmaceutical Excipients (JPE), 1993

STORAGE AND STABILITY

In its dry form, VANZAN is resistant to degradation by bacteria, and a shelf life of 5 years from the date of production is guaranteed if the product is stored in a cool and dry place. The use of a preservative is, however, recommended if solutions of VANZAN are stored longer than 24 hours. VANZAN is compatible with most commonly used preservatives.

TECHNICAL SERVICE

For further information or technical service, please contact R.T. Vanderbilt Company or your local technical sales representative. Samples and additional technical literature, as well as detailed specifications of VANZAN, are available on request.

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